

22d, 23d, 26th, 28th; Riley, Ill., 5th; Salina, Kan., 9th; Ninneseah, Kans., 30th; Moorestown, N. J., 22d; Wauseon, Ohio, 1st, 12th, 30th; Napoleon, Ohio, 1st, 5th, 30th; Mount Angel, Oregon, 14th; Memphis, Tenn., 2d; Nashville, Tenn., 16th; Wytheville, Va., 6th, 17th; Dale Enterprise, Va., 25th; Blakely, Wash., 9th; Prairie du Chien, Wis., 5th, 30th.

SAND STORMS.

San Carlos, Ariz.: about noon of the 7th a violent whirlwind passed over this station, carrying with it a column of sand and dust about two hundred feet in diameter and one thousand feet in height. The column revolved from right to left, and moved slowly from the southwest to the northeast. This was followed fifteen minutes later by a smaller but similar phenomenon.

Fort Grant, Ariz.: from 11 a. m. to 7 p. m. of the 15th a severe southeasterly gale prevailed, attaining a maximum velocity of forty miles per hour, and raising heavy clouds of sand which entirely obscured the sky, and at times rendered objects only a few yards distant invisible. Whirlwinds were numerous, and heavy sand drifts, resembling snow drifts in shape, were noticed after the storm. A number of trees along the creeks and several light buildings were prostrated. High winds, with sand storms, occurred also on the 7th and 8th.

Sand storms occurred also at the following places:

Abilene, Tex., 3d; El Dorado, Kans., 3d, 5th; Pekin, Ill., 4th; Fort McDowell, Ariz., 7th; Yuma, Ariz., 9th, 10th; Keeler, Cal., 17th, 30th.

WATER-SPOUTS.

Captain Hill, of the bark "Neptune," reports having ob-

served three large water-spouts at 1 a. m. on the 1st in N. $32^{\circ} 0'$, W. $77^{\circ} 40'$. The wind at the time was blowing a fresh gale from ssw., with rain squalls and rough sea. The bark "Bristol," on the 1st, at 2 p. m., in N. $39^{\circ} 50'$, W. $68^{\circ} 0'$, encountered a whirlwind which lasted twenty-five minutes. The water was carried into the air as high as the topgallant yard; the vessel sustained no damage.

Capt. James Lord, of the s. s. "Advance," reports having observed two water-spouts on April 9th, 4.30 p. m., in S. $9^{\circ} 46'$, W. $34^{\circ} 40'$. The spouts travelled ne. at a slow rate, and revolved with the sun, drawing water upward very rapidly. They were very narrow at the base. No change was noted in air temperature; the barometer fluctuated, and the wind was se., force 4, with almost clear weather, preceded by light rain showers.

Capt. Joseph Dove, of the s. s. "Roseville," reports having observed a dangerous water-spout April 18th, 4 p. m., in N. $39^{\circ} 40'$, W. $55^{\circ} 00'$, during the prevalence of a heavy nne. squall, accompanied by thunder and lightning.

Sanford, Fla.: on the 23d fresh southerly wind prevailed until 5.30 p. m., when it changed suddenly to northerly and blew for a time at the rate of thirty-six miles per hour. When the change in the wind direction occurred two water-spouts, each about thirty feet in height, formed on Lake Monroe.

SUN SPOTS.

Mr. H. D. Gowey, of North Lewisburg, Champaign Co., Ohio, reports having observed sun spots on the 19th, 21st, 23d, and 30th.

VERIFICATIONS.

INDICATIONS.

The predictions for April, 1887, were made by 1st Lieutenant H. H. C. Dunwoody, 4th Artillery, U. S. Army, Acting Signal Officer and Assistant; they were verified by 1st Lieutenant Robert Craig, 4th Artillery, U. S. Army, Acting Signal Officer and Assistant.

The detailed comparison of the tri-daily indications for April, 1887, with the telegraphic reports of the twenty-four hours for which the indications were prepared, shows the general average percentage of verifications to be 77.66. The percentages for the different elements are: Weather, 81.37; wind, 72.36; temperature, 74.36. By states, etc., the percentages are: For Maine, 71.38; New Hampshire, 70.65; Vermont, 75.00; Massachusetts, 76.85; Rhode Island, 75.99; Connecticut, 77.84; eastern New York, 79.91; western New York, 77.10; eastern Pennsylvania, 78.68; western Pennsylvania, 76.34; New Jersey, 80.63; Delaware, 81.84; Maryland, 78.58; District of Columbia, 77.47; Virginia, 77.61; North Carolina, 80.26; South Carolina, 79.17; Georgia, 81.62; eastern Florida, 80.51; western Florida, 83.20; Alabama, 81.93; Mississippi, 84.73; Louisiana, 86.34; Texas, 88.36; Arkansas, 79.30; Tennessee, 78.01; eastern Tennessee, 77.50; Kentucky, 76.34; Ohio, 77.93; West Virginia, 77.93; Indiana, 75.52; Illinois, 68.19; eastern Michigan, 78.28; western Michigan, 75.30; Wisconsin, 73.02; Minnesota, 71.51; Iowa, 73.08; Kansas, 66.81; Nebraska, 70.30; Missouri, 66.44; Colorado, 70.54; eastern Dakota, 71.08.

There were eight omissions to predict, out of 8,508, or 0.09 per cent. Of the 8,500 predictions that have been made, seven hundred and thirty-seven, or 8.67 per cent., are considered to have entirely failed; two hundred and seventy-four, or 3.22 per cent., were one-fourth verified; 1,656, or 19.48 per cent., were one-half verified; 1,068, or 12.56 per cent., were three-fourths verified; 4,765, or 56.06 per cent., were fully verified, so far as can be ascertained from the tri-daily reports.

The predictions for the Pacific coast during April, 1887, were made at San Francisco, Cal., by 2d Lieutenant J. E. Maxfield, Signal Corps, U. S. Army, Assistant, and were verified by 2d Lieutenant Frank Greene, Signal Corps, U. S. Army, Assist-

ant. The percentages of predictions verified are: Washington Territory, 70.31; Oregon, 63.53; northern California, 79.42; southern California, 75.85.

Below are given for the Pacific coast the percentages of indications verified for March, 1887; this data was received too late for publication in the REVIEW of that date. The predictions were made by 2d Lieutenant J. E. Maxfield, Signal Corps, U. S. Army, Assistant; they were verified by 2d Lieutenant Frank Greene, Signal Corps, U. S. Army, Assistant. The percentages for the different districts are: Washington Territory, 77.62; Oregon, 71.36; northern California, 80.86; southern California, 84.87.

CAUTIONARY SIGNALS.

Of the total number of signals ordered during April, 1887, it was practical to determine the verifications of one hundred and twenty-six; of these, one hundred and eight, or 85.71 per cent., were fully verified both as to direction and velocity. Number of signals ordered for on-shore winds, one; verified, one, or 100 per cent. Number of signals ordered for northeast winds, eight; fully verified both as to direction and velocity; eight, or 100 per cent. Number of signals ordered for northwest winds, twenty-seven; fully verified both as to direction and velocity, twenty-two, or 81.48 per cent. Number of signals ordered without regard to direction, ninety; verified, seventy-seven, or 85.55 per cent. Number of signals ordered late, i. e., after the verifying velocity had begun, thirteen, or 10.32 per cent.

In addition to the above, two hundred and twenty-four signals were ordered at display stations, the verifications of which it was impracticable to determine.

In twenty-five instances winds were reported which would have justified the display of cautionary signals, but for which no signals were ordered, and in four instances winds which would have justified the display of on-shore signals, but for which no signals were ordered.

COLD-WAVE SIGNALS.

Total number of cold-wave signals ordered, the verifications

of which were determined, eighty-three; verified, seventy, or 84.34 per cent. Seven signals were ordered, the verifications of which it was impracticable to determine.

In addition to the above, in two hundred and six instances, the signals ordered from this office were repeated by the observers at the regular stations to towns in their vicinity. The verifications of these it was impracticable to determine.

LOCAL VERIFICATIONS.

The following is from the April, 1887, report of the "Minnesota Weather Service:"

Verifications of weather signals for Minnesota were 86 per cent. for weather and 78 per cent. for temperature; for eastern Dakota, 93 per cent. for weather and 90 per cent. for temperature; for northern Iowa, 83 per cent. for weather and 85 per cent. for temperature.

The following is from the "Michigan Crop Report" for April, 1887:

Weather and temperature signals are now displayed in one hundred and ten cities and towns in Michigan. The predictions of weather and temperature have been verified 78.6 per cent. for this month.

Weather signals carried on the Chicago and Grand Trunk Railway; Detroit, Grand Haven and Milwaukee Railway; and the Port Huron and Northwestern Railway have been found to supply a long-felt want, and are received with great favor by the agricultural districts through which these roads pass.

The predictions of weather and temperature have been verified as follows: Chicago and Grand Trunk Railway, 77.2 per cent.; Detroit, Grand Haven and Milwaukee Railway, 79.6 per cent.; and the Port Huron and Northwestern Railway, 83.2 per cent.

Two cold-wave signals were ordered this month, both being verified. The one of the 4th and 5th was the most prominent. The signal was ordered at 12.45 a. m. of the 4th, temperature at 62° 6, and at 7 a. m. the temperature read 35° 4, and reached the minimum, 19° 1, at the central office on the morning of the 5th, twenty-four hours after the signal was ordered displayed. The range of temperature was 40° 7 in less than eight hours from the time the temperature began to fall. Frosts were reported all over the state on the morning of the 5th, and would undoubtedly have caused much damage to agriculture if this warning had not been thus spread throughout the state, enabling all interested to protect their crops.

The "South Carolina Weather Review" of April, 1887, says:

The percentage of verification of weather and temperature predictions for the whole state was: for weather, 93.0 per cent.; for temperature, 89.8 per cent.

STATE WEATHER SERVICES.

The following extracts are republished from the reports for April, 1887, of the directors of the various state weather services:

The "Alabama Weather Service," P. H. Mell, jr., of the Agricultural and Mechanical College, Auburn, director:

The dry condition of the weather has continued through April and vegetation has suffered materially. Most of the rain reported by the observers for the month fell during the 18th, 22d, and 23d, and the earth was so dry the moisture was immediately absorbed, leaving in a few hours but little trace of the precipitation. For this state the April precipitation was 4.09 inches below the average. The temperature has been very nearly normal, and no great extremes were reported from any quarter.

The state has been remarkably free from violent storms of wind; only one, on the 22d, was reported during the month, and it was quite limited in its destructive effects. At Tusculumbia, on that date, a thunder-storm set in at 1 p. m. with a succession of clouds during the day, followed at 3 p. m. by a severe wind storm blowing with gale force, and demolishing fences, etc. Thermometer, 62°. Hail in great quantity, nearly covering the ground; hail-stones very large, some quite irregular in shape. Leaves stripped from the trees and torn in shreds. This storm did much damage to grape vines. A large number of window glass was destroyed. The damage from the hail is supposed to be as much as \$500 to \$800.

Summary.

Mean temperature, 64°; highest temperature, 90°, at Troy, on the 30th; lowest temperature, 24°, at Gadsden, on the 6th; range of temperature, 66°; greatest monthly range of temperature, 64°, at Gadsden; least monthly range of temperature, 36°, at Greenville; mean daily range, 23° 7; greatest daily range of temperature, 46°, at Gadsden, on the 11th; least daily range of temperature, 8°, on the 7th, at Demopolis; mean depth of rainfall, 2.20 inches; mean daily rainfall, .073 inch; greatest depth of monthly rainfall, 3.99 inches, at Carrollton; least depth of monthly rainfall, 0.95 inch, at Greenville; greatest daily local rainfall, 2.88 inches, at Carrollton, on the 22d.

Average number of days on which rain fell, 4; average number of cloudy days, 5; average number of fair days, 6; average number of clear days, 19.

Warmest day, 12th; coldest day, 6th.

Prevailing direction of wind, southwest.

The "Arkansas Weather Service," Mr. George R. Brown, of Little Rock, director:

Frosts were reported on the 1st from Fort Smith, Lead Hill, Portia, Conway, and Palarm; on the 5th at Fort Smith, Little Rock, Lead Hill, Palarm, Eureka Springs, and a general light frost on the 24th over almost the entire state as far south as Helena and Texarkana, and very cold at Marianna on the 18th and Judsonia on the 27th.

A light snow fell at Fayetteville the night of the 17th, and the temperature the morning of the 18th was 38°.

The rainfall was less than the average, the deficiency being greatest in the central and southern parts of the state, where it was 5 inches less than the average; in the northern and northeastern portions it was about 2 inches less than usual. Two cold waves passed over the state, one entering at the extreme northwest on the night of the 3d, reached the central portions by the night of the 4th, and crossed the entire state by the night of the 5th. The other continued irregularly over the state from the 23d to the 27th.

The highest reported temperatures in the state were 95°, at Dallas; 94°, at Fayetteville; 93°, at Conway and Palarm; 92°, at Brinkley and Russellville, and 91°, at Alexander and Fort Smith. The lowest were 26°, at Palarm; 27°, at Fayetteville and Lead Hill; 28°, at Eureka Springs, and 29° at Russellville.

The greatest amount of rain was at Lead Hill, 3.02; the least, at Conway, 0.10 inches.

The "Monthly Review of the Illinois Weather Service," Col. Charles F. Mills, of Springfield, director:

The noteworthy meteorological features of the month of April were the continued drought from the 1st to the 17th; the remarkable maximum temperature, 95°—the highest since observation began; the cyclonic storm of the 22d, and the unusual number of high winds reported.

Temperature.—The mean temperature of the state for April, 53°, was 1° 5 above the April normal for the past thirteen years; April, 1878, with a mean temperature of 56° 1, was the warmest, and April, 1881, 45° 3, was the coolest. The mean temperature of the northern counties, 50° 1, was 1° above the April normal; the mean of the central counties, 53°, was 0° 6 above, and of the southern counties, 56° 8, was 0° 3 above the April normal. In the southern counties reporting, excepting Madison, Saint Clair, Pope, and Alexander, the mean temperatures were below the normal; but the very marked departures above the normal in the two first-named counties caused the average departure to exceed the normal by less than one-third of a degree.

A considerable decrease in the range of the monthly mean temperature from the northern to southern extremities is noted. The lowest monthly mean reported was 44° 2 from Lake Forest, Lake Co., and the highest, 60° 9, from Benton, Franklin Co., a range of 16° 7 for the state.

The highest temperature, 95°, is noteworthy as being the highest on record for April. It was reported from Jordan's Grove, Randolph Co., on the 13th. The lowest temperature, 5°, was reported from Galena, Jo Daviess Co., on the 4th. The dates of the occurrence of maximum temperature were from the 12th to the 14th for the state, and of the minimum on the 4th and 5th in the northern and central counties, and the 1st and 5th in the southern counties, with but few exceptions.

Precipitation (inches and hundredths).—A drought prevailed from the 1st to the 16th of the month, broken by general rainfall on the 17th, that was light in the northern counties, and heavy in the central and southern counties. From the latter date to the end of the month light rains were frequent in the northern counties, moderately heavy in the central counties, and heavy in the southern counties.

The average precipitation for the state for the month, 2.52, was 0.78 below the April normal for a term of ten years. The greatest average April precipitation during that period was 4.17, occurring in 1883, and the least, 2.02, in 1879. The average for the northern counties, 1.13, was 1.81 below the April normal for ten years; for the central counties, 2.69, was 0.56 below, and for the southern counties, 3.97, was 0.13 above.

From the following table it will be seen that the average April precipitation for the state has a range of nearly one inch from the northern to southern parts of the state, a gradual increase going south:

Territory.	April.									
	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.
Northern counties.....	3.72	2.14	4.13	1.80	4.31	3.18	2.64	3.59	2.71	1.13
Central counties.....	3.54	1.47	3.99	2.36	4.14	4.61	2.23	4.98	2.46	2.69
Southern counties.....	5.20	2.46	3.24	3.31	2.81	4.73	3.57	4.87	4.26	3.97
The state.....	4.15	2.02	3.79	2.49	3.75	4.17	2.81	4.05	3.20	2.52

The area of the state receiving a monthly precipitation of from three to six inches is bounded on the north by latitude 39° 30', and on the south by 37° 20', the heavy rainfall of the 17th and 21st-22d affecting that section most.